National Aeronautics and Space Administration

DSCOVR Magnetometer Observations

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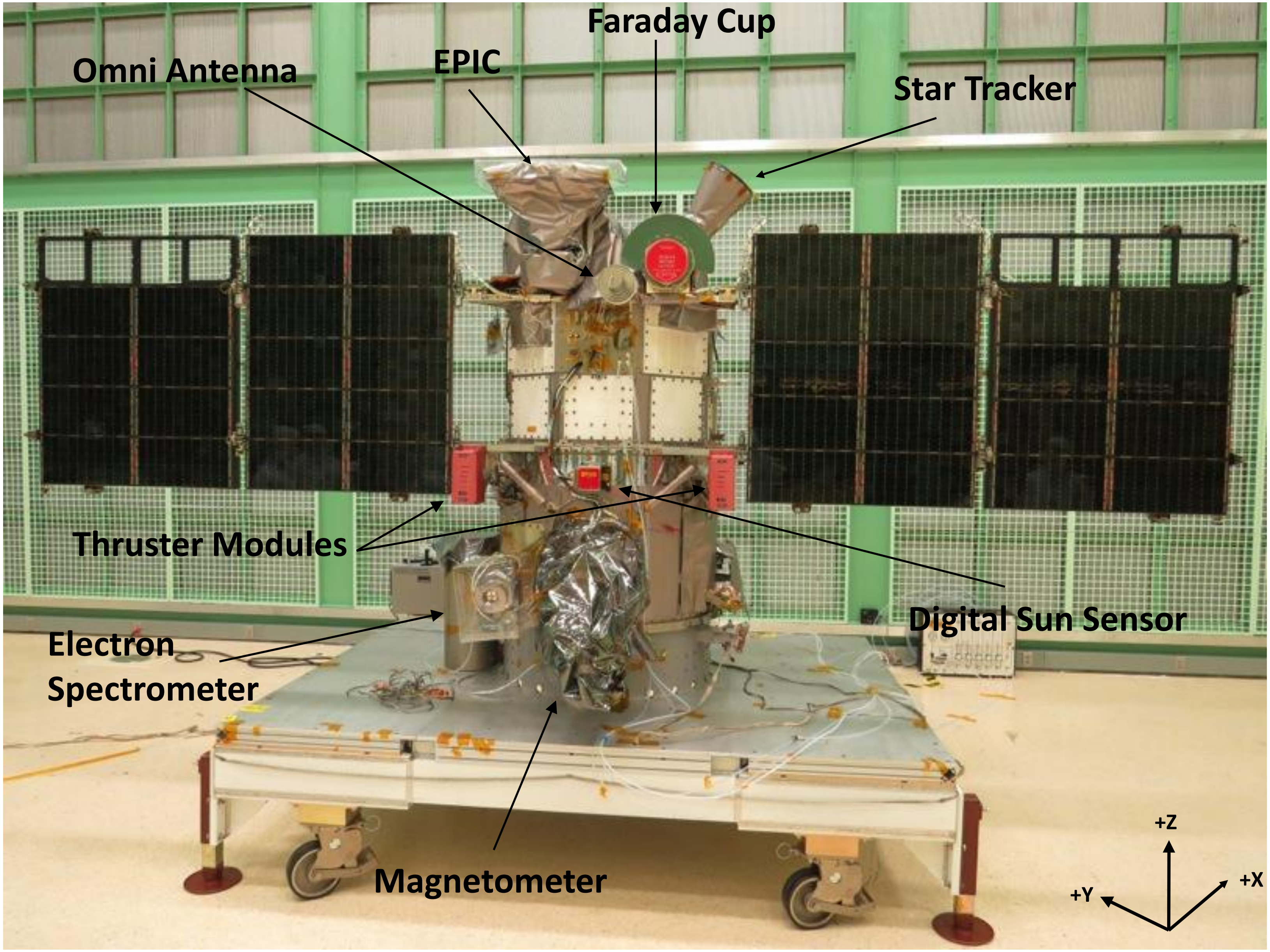
DSCOVR

DEEP SPACE CLIMATE OBSERVATORY

advanced warning of approaching solar storms

http://www.nesdis.noaa.gov/DSCOVR

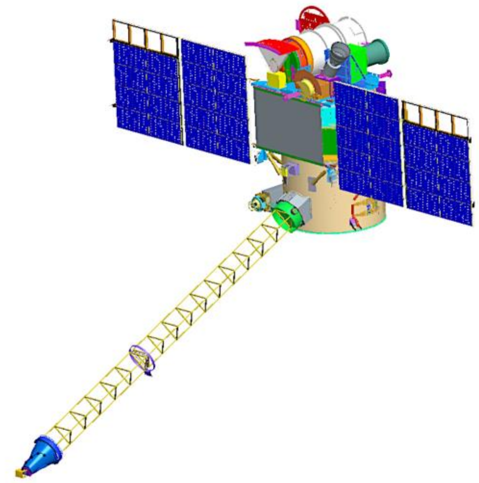
Locations of the Instruments



Goddard Fluxgate Magnetometer

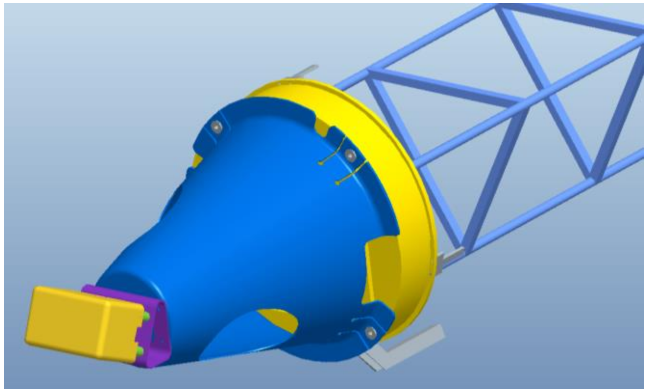
The Fluxgate Magnetometer measures
the interplanetary vector magnetic field

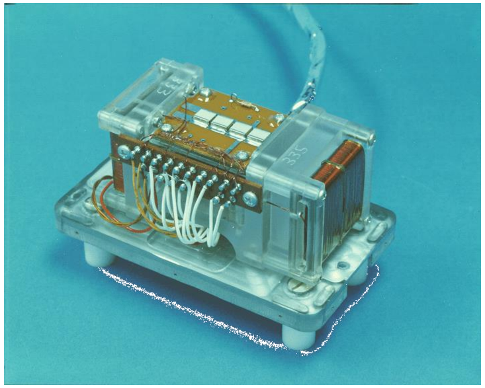
It is located at the tip of a 4.0 m boom
to minimize the effect of spacecraft fields



Magnetometer

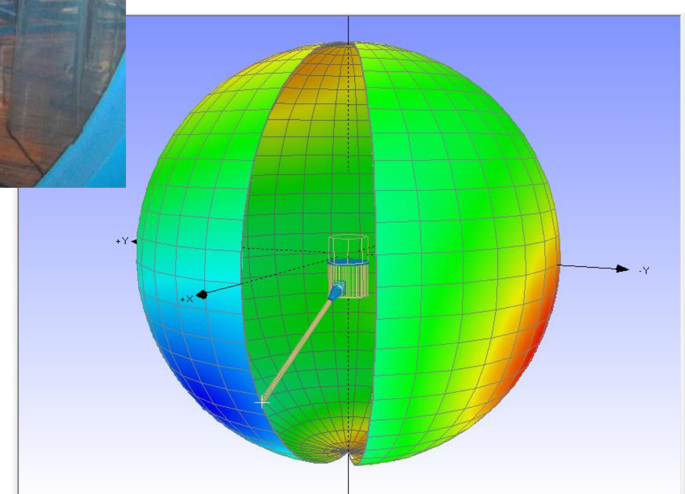
Requirement	Value	Method	Performance
Range	0.1-100 nT	Test	0.004-65,500 nT
Accuracy	+/- 1 nT	Measured	+/- 0.2 nT
Cadence	1 min	Measured	50 vector/sec





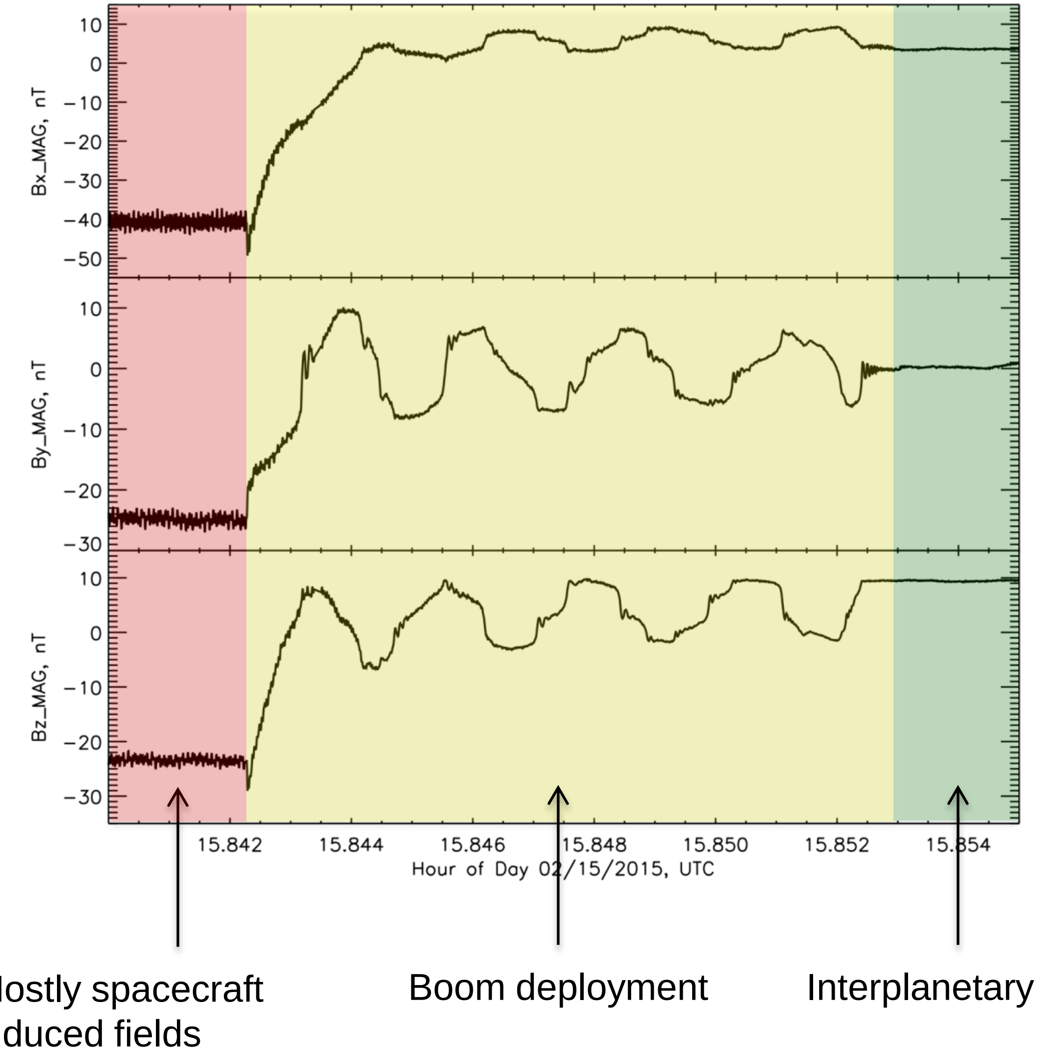
Pre-flight Calibration

- Determined the magnetometer zero levels, scale factors, and magnetometer orthogonalization matrix.
- Determined the spacecraft generated magnetic fields
  - Subsystem level magnetic tests. Reaction wheels, major source of dynamic field, were shielded
  - Spacecraft unpowered magnetic test in the GSFC 40’ magnetic facility



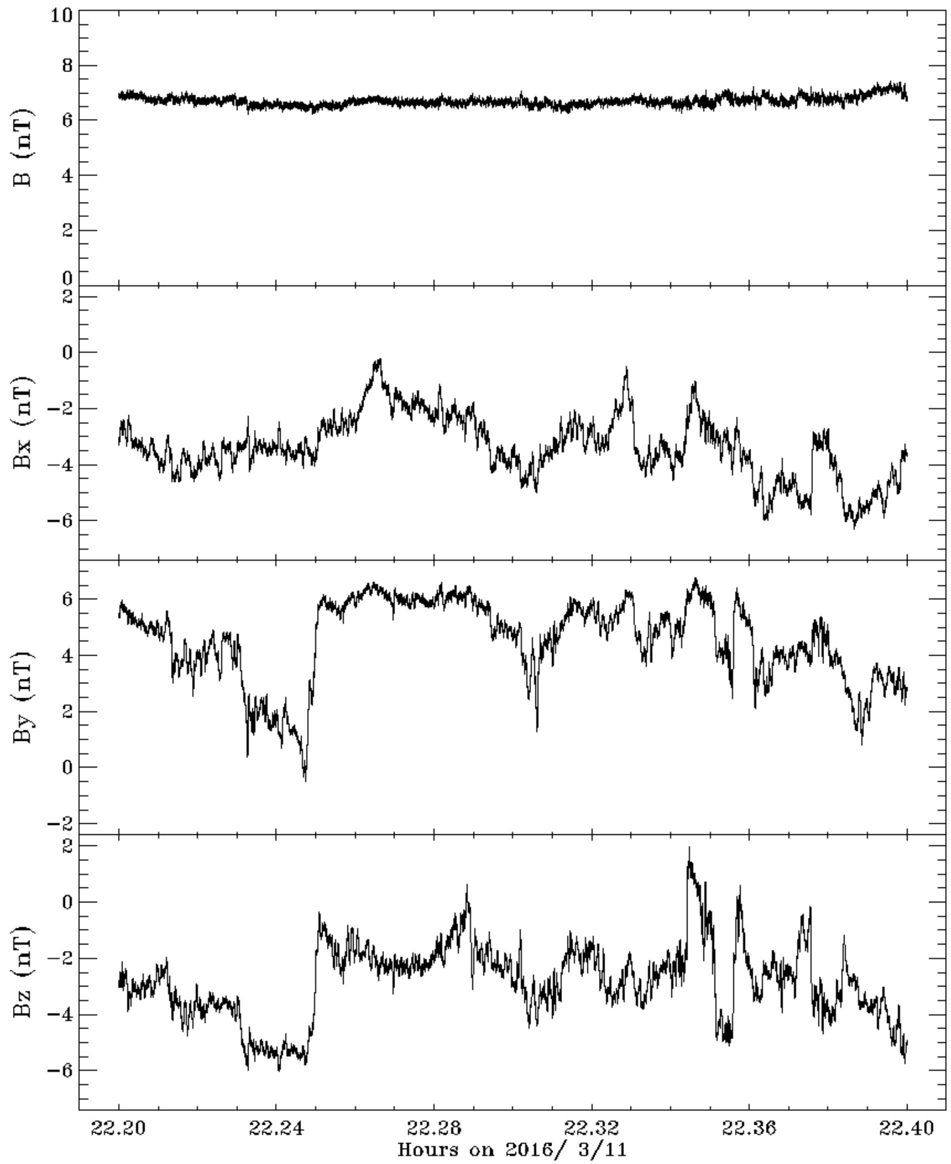
In-Flight Boom Deployment

- Nominal deployment on 2/15/15, seen as 4.4 rotations in the magnetometer components

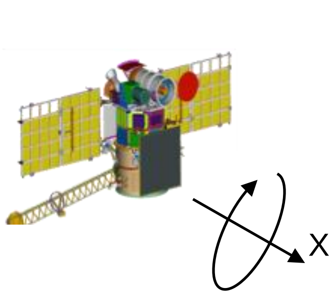


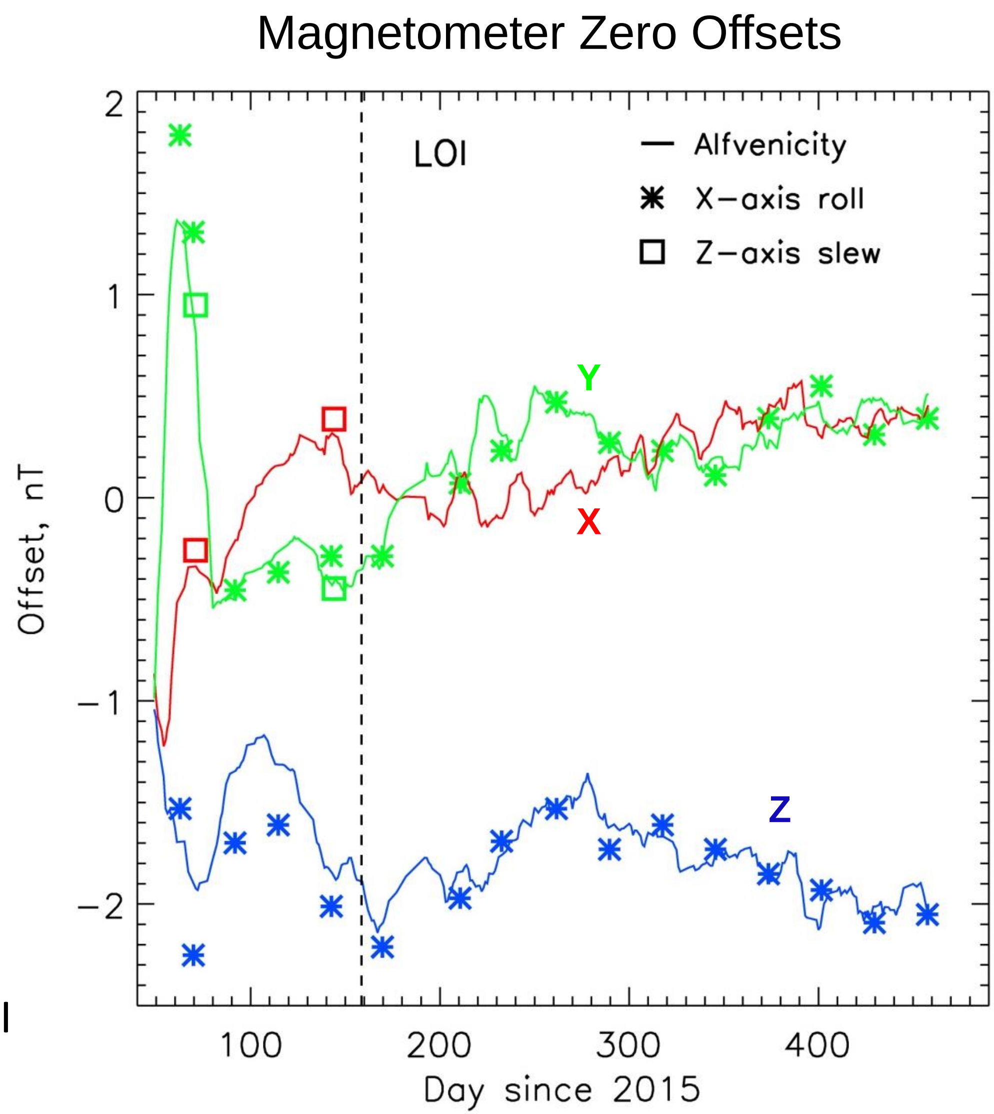
Alfven Waves in the Solar Wind

- The solar wind contains magnetic field rotations that preserve the magnitude of the field, so called Alfven waves.
- Alfven waves are ubiquitous and are possible to identify with automated routines.
- Systematic deviations from a constant field magnitude during these waves are an indication of spacecraft induced offsets.
- Minimizing the deviations with slowly changing offsets allows in-flight calibrations.



In-Flight Magnetometer Calibrations



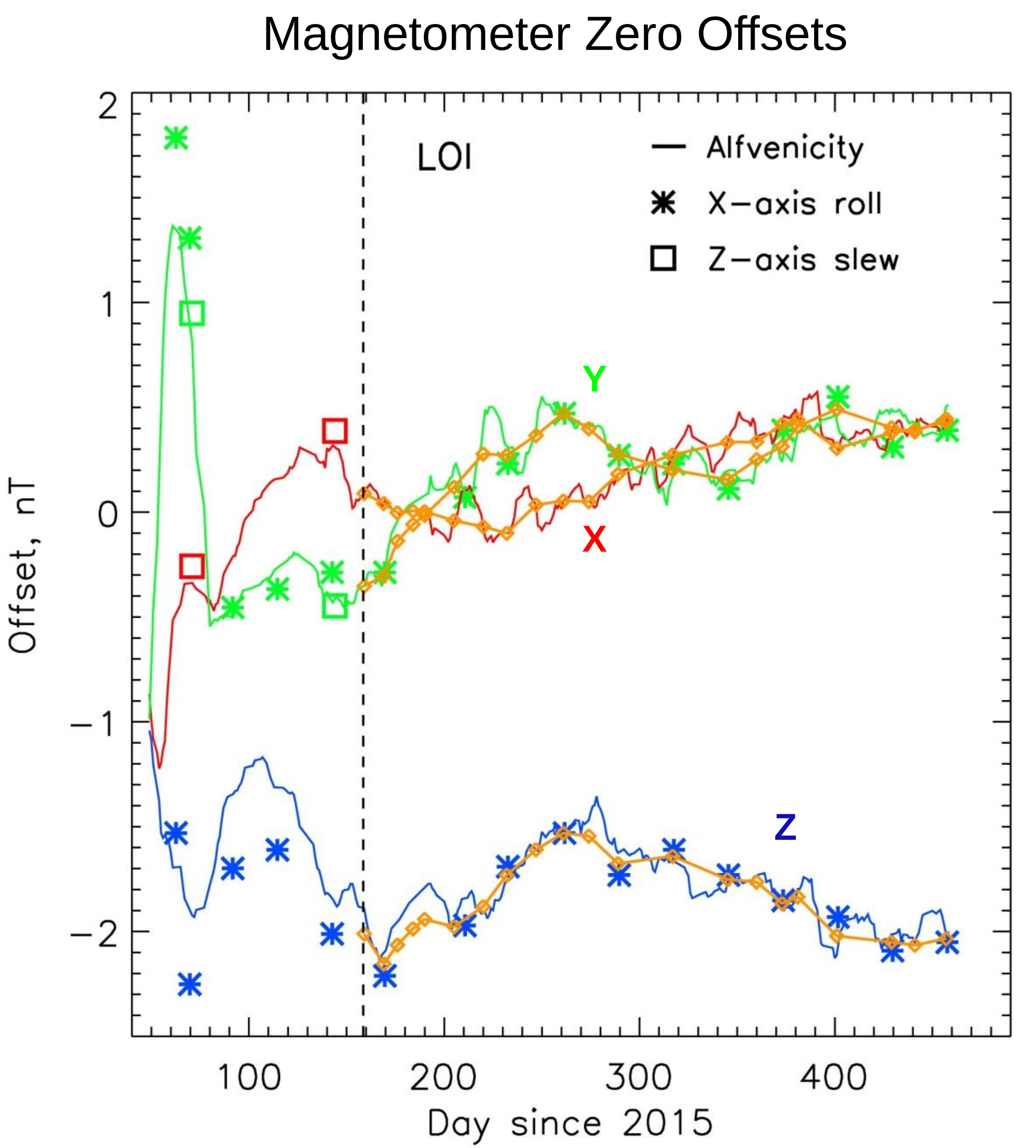


- X axis Roll and Z axis Slew data is consistent with ground calibration estimates
- Independent zero offset determination by rolls, slews and using solar wind Alfvenicity give consistent values
- Time variation is consistent with yearly orbital change.
- Resulting magnetic field accuracy since LOI is ~0.2 nT, exceeding requirements.

In-Flight Magnetometer Calibrations (2)

- Orange curve shows the offset values provided to NOAA SWPC.

- Updates are provided at least monthly or when sudden changes are identified.



Intercalibrations with ACE and Wind

Require spacecraft separation <25 Re.

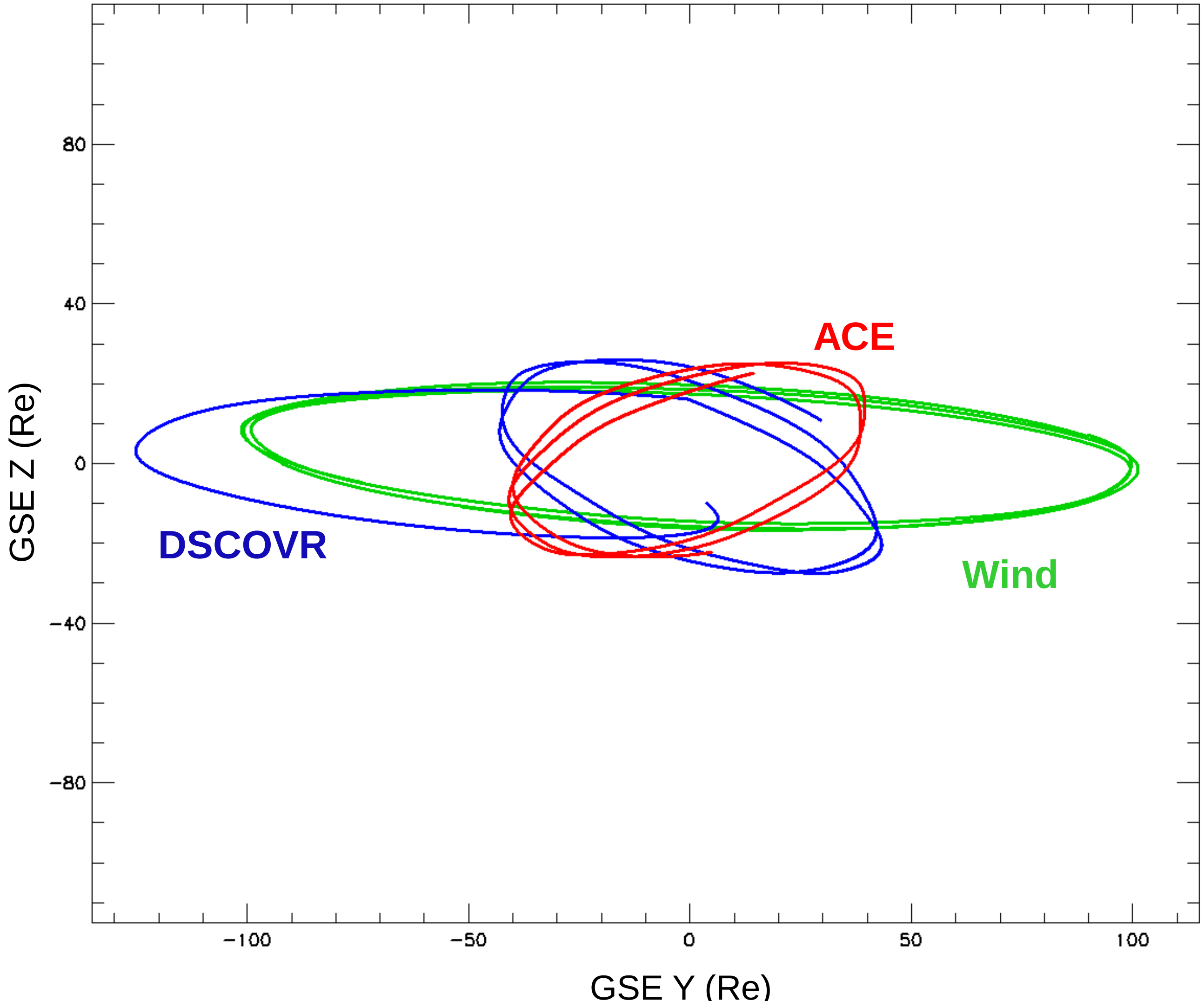
ACE – DSCOVR:

June 8 – 19, 2015
Sept 1 – 18, 2015
Nov 27 – Dec 13, 2015
Feb 24 – Mar 10, 2016

Wind – DSCOVR:

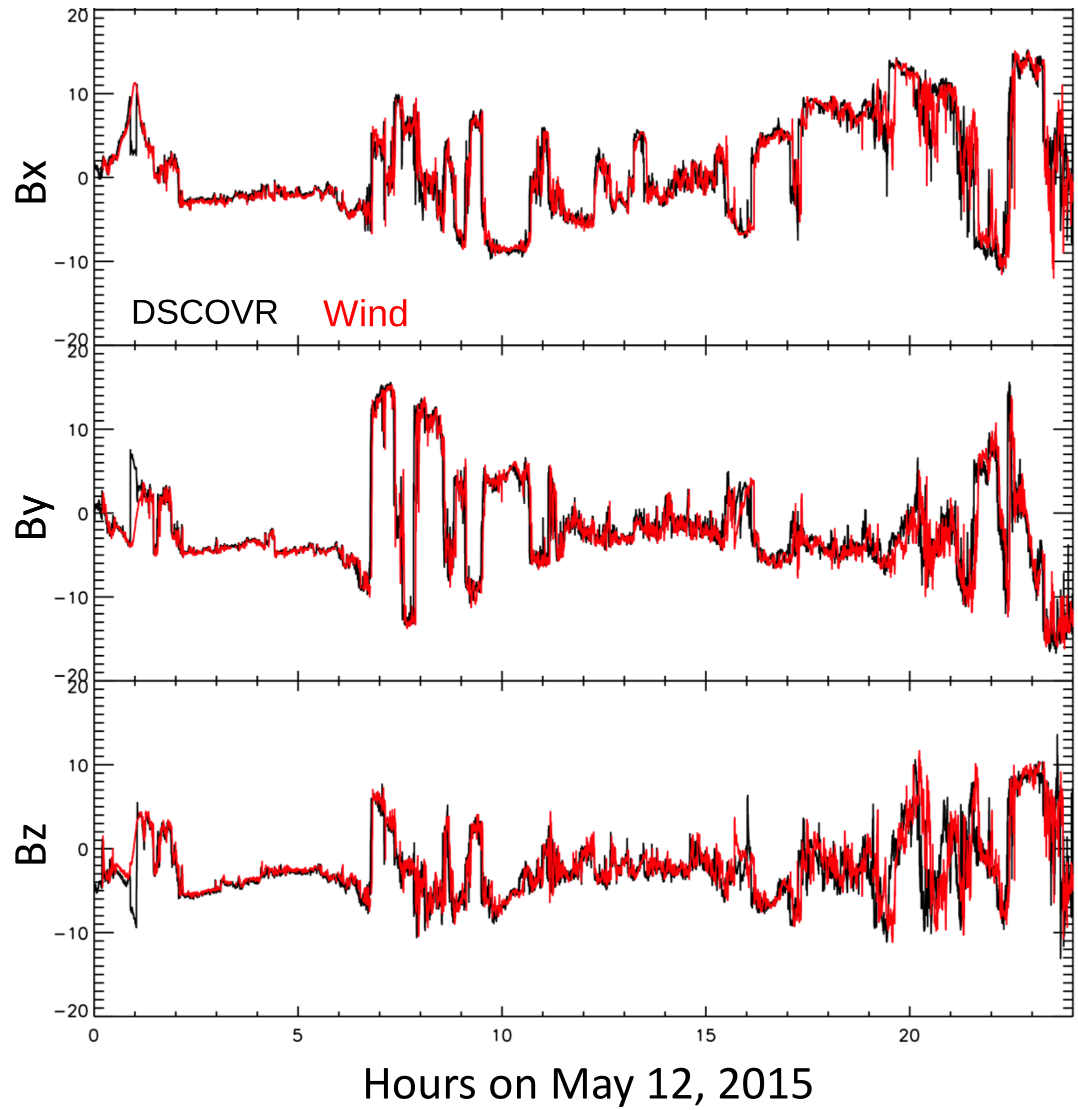
May 12, 2015
July 4 – 20, 2015
Oct 6 – 23, 2015
Dec 29, 2015 –
- Jan 3, 2016
Mar 23 – Apr 6, 2016

DSCOVR, ACE and Wind Orbits



Wind-DSCOVR Comparison

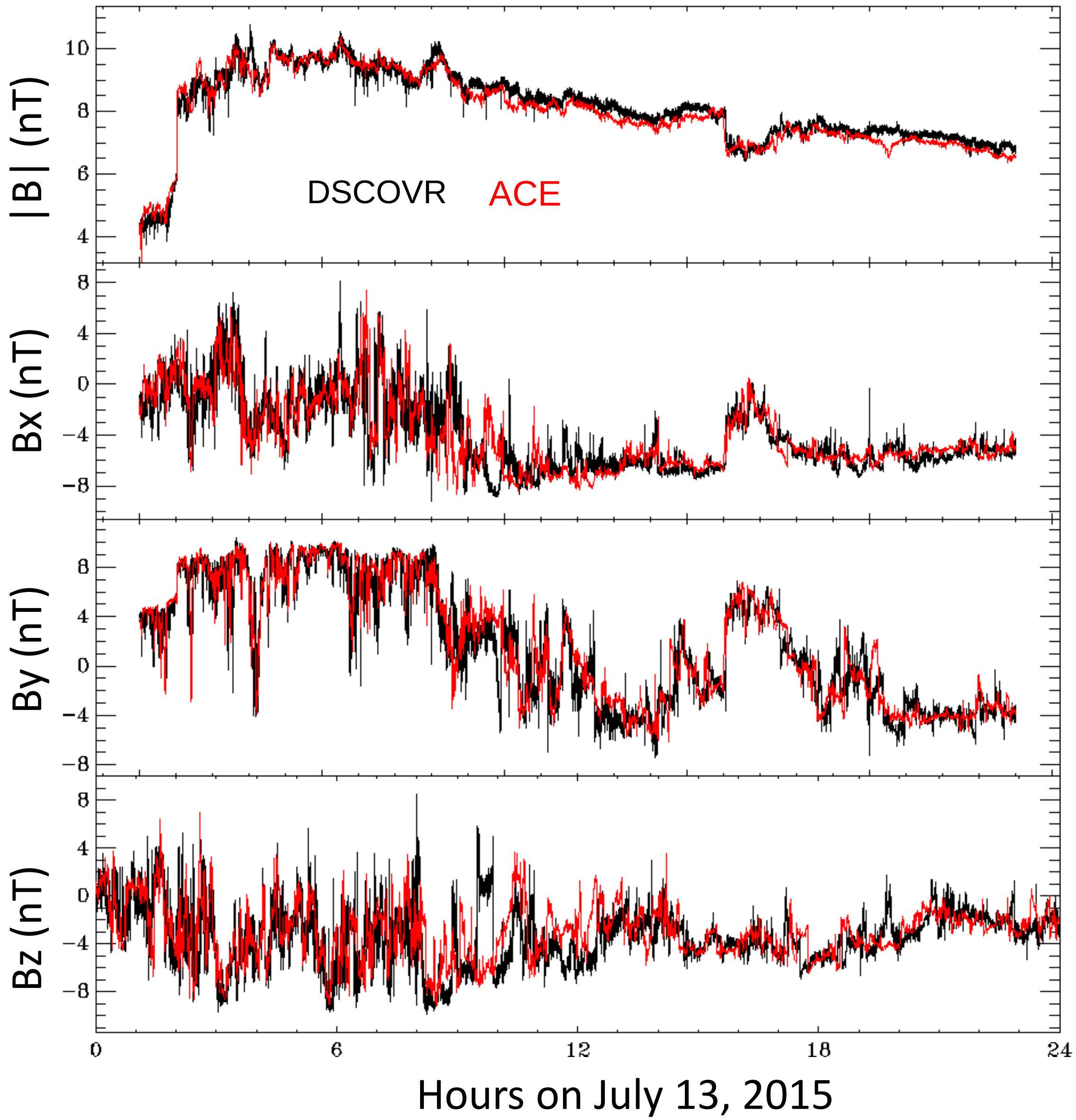
Comparison with Wind spacecraft measurements show good agreement. DSCOVR data is in black. The time shifted Wind data (to allow for solar wind propagation) is plotted in red. Small deviations are consistent with spacecraft separation.



ACE-DSCOVR Comparison

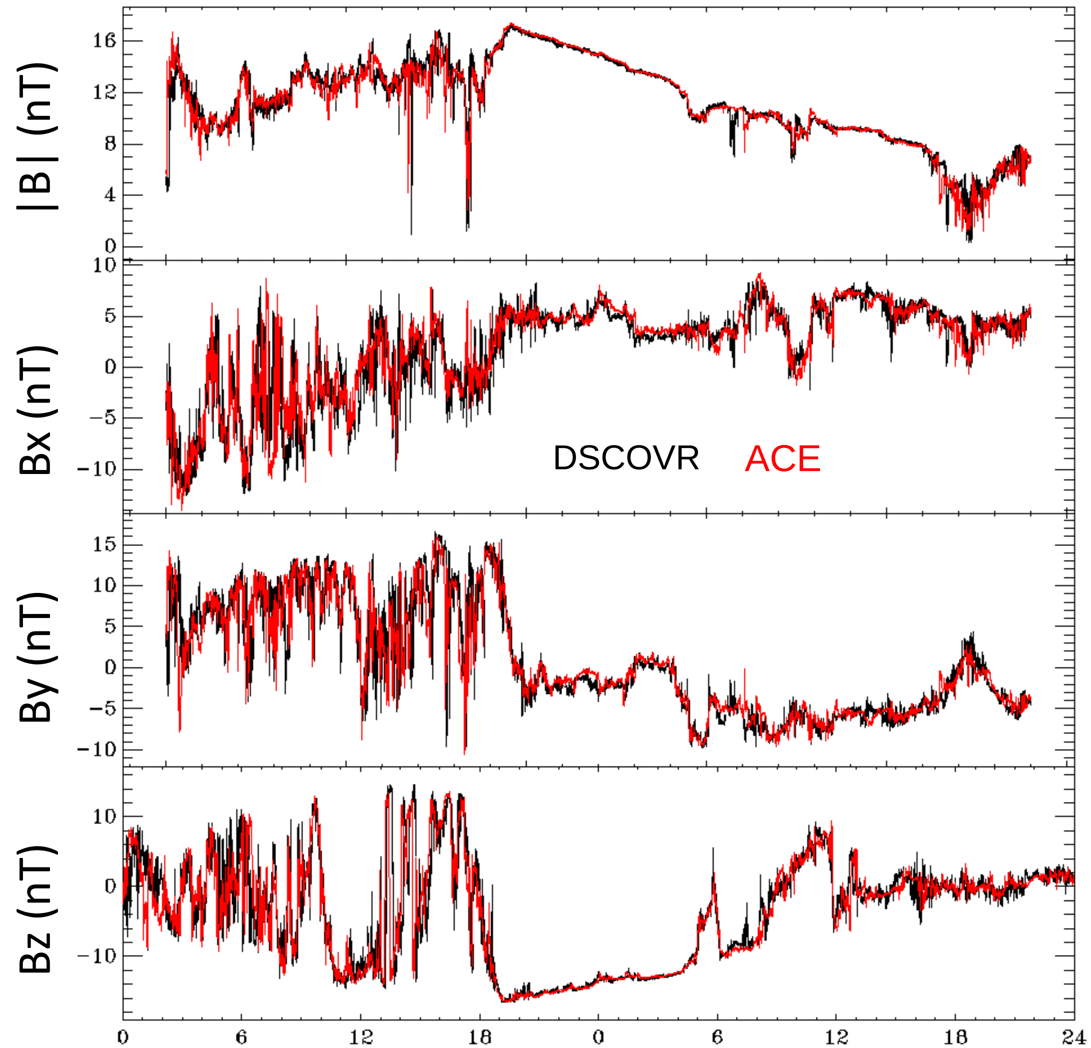
Comparison with ACE spacecraft measurements also show good agreement. DSCOVR data is in black. The ACE data in red is not time shifted. Small deviations are consistent with spacecraft separation.

Interplanetary shock jump conditions at the beginning of the day agree as measured by the two spacecraft.



ACE-DSCOVR Comparison (2)

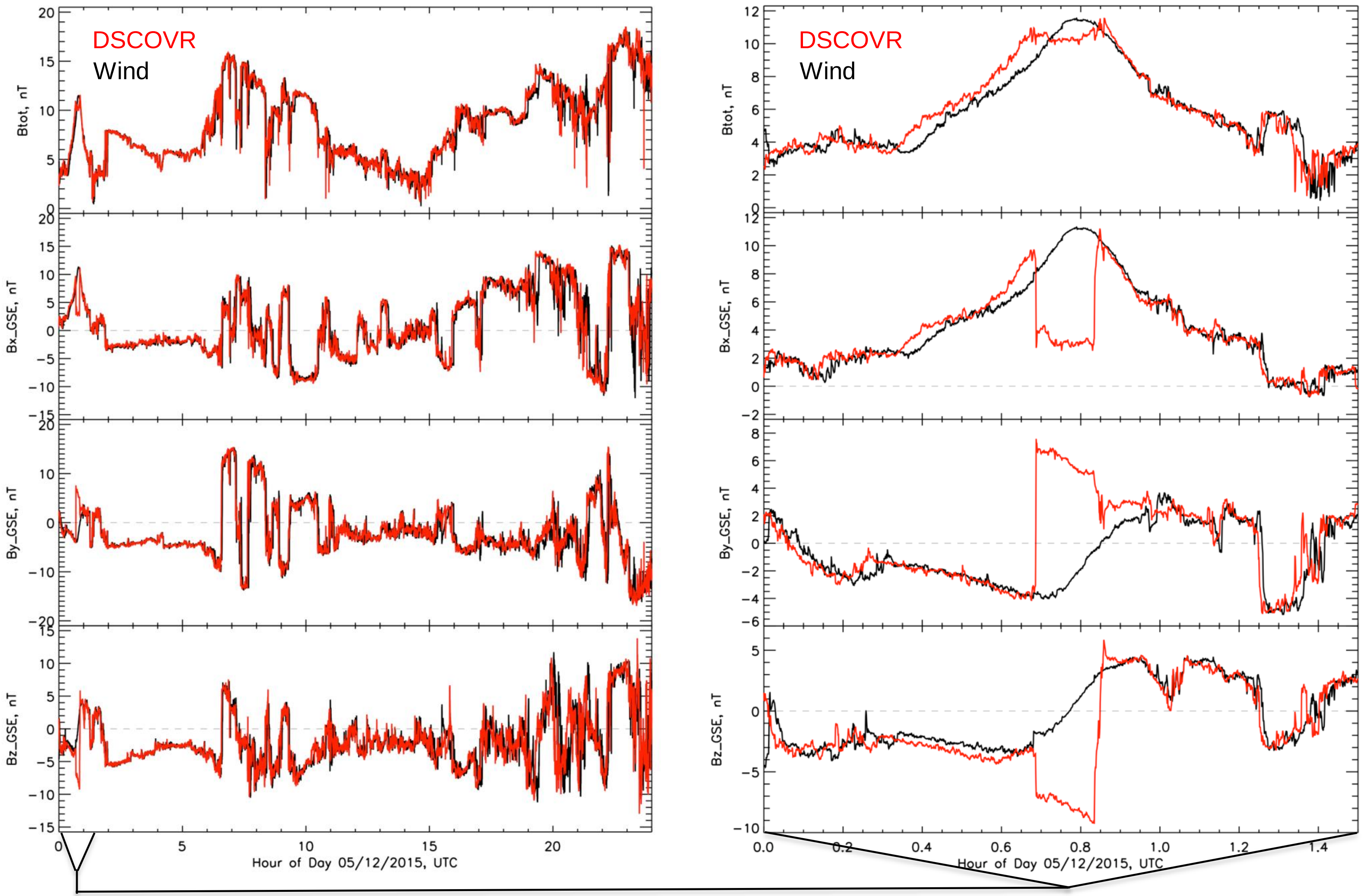
The 2015 Dec 31 – 2016 Jan 1 ICME was measured by both spacecraft with identical values.



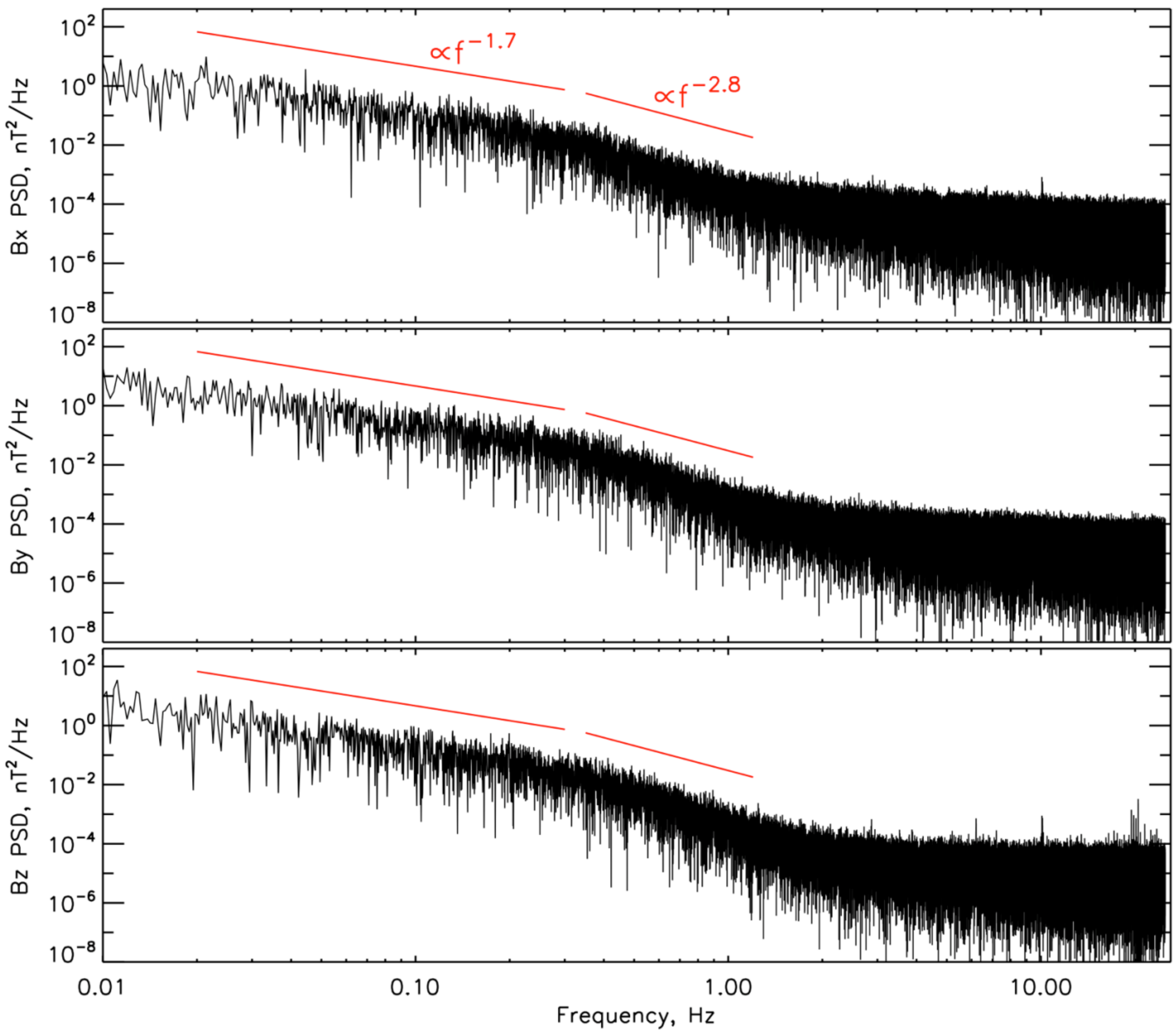
Hours on 2015/12/31 and 2016/1/1

DSCOVR Science: Small Structures

- DSCOVR and Wind separated by < 10 Re perpendicular to SW

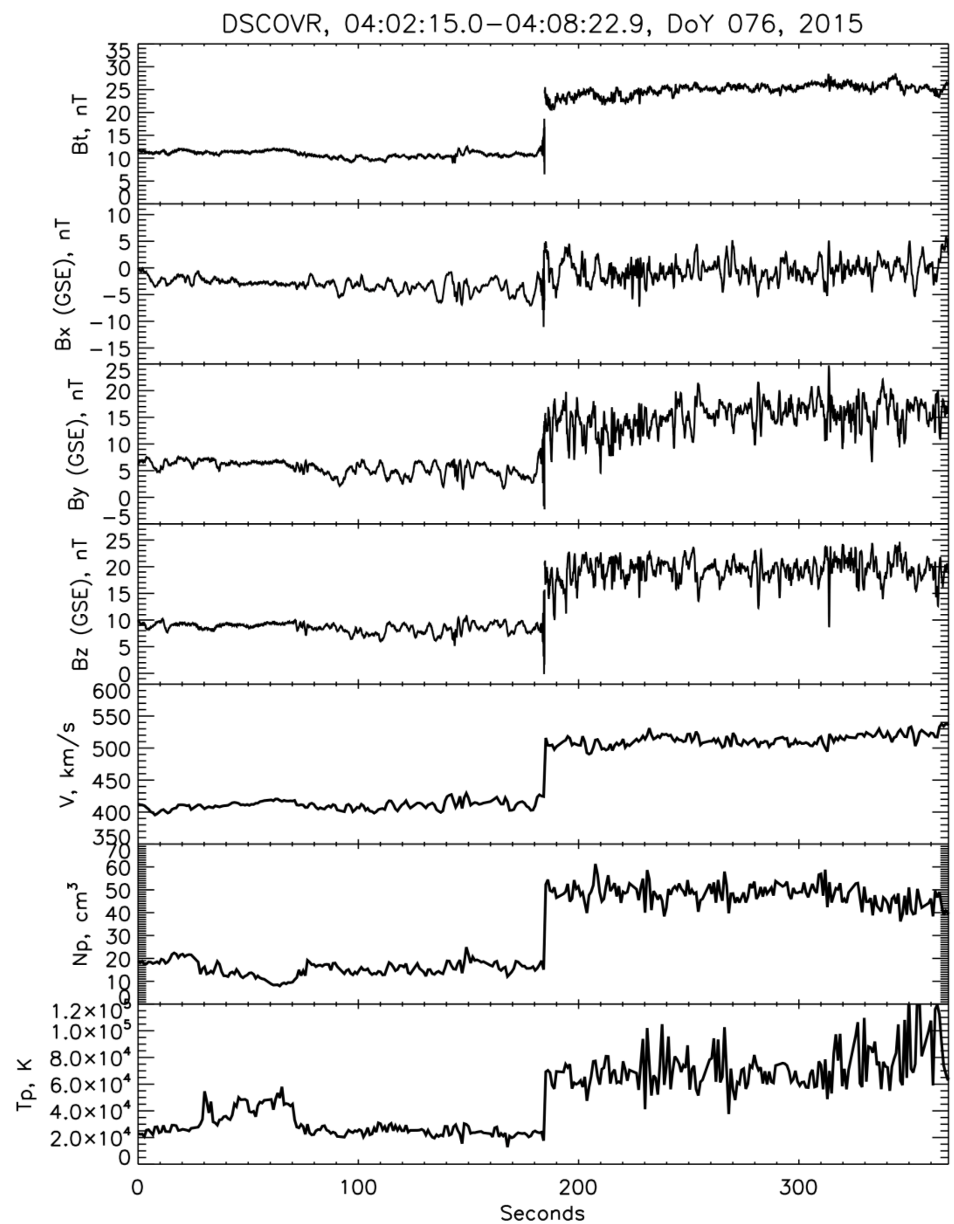


- Inertial and dissipation ranges of magnetic turbulence

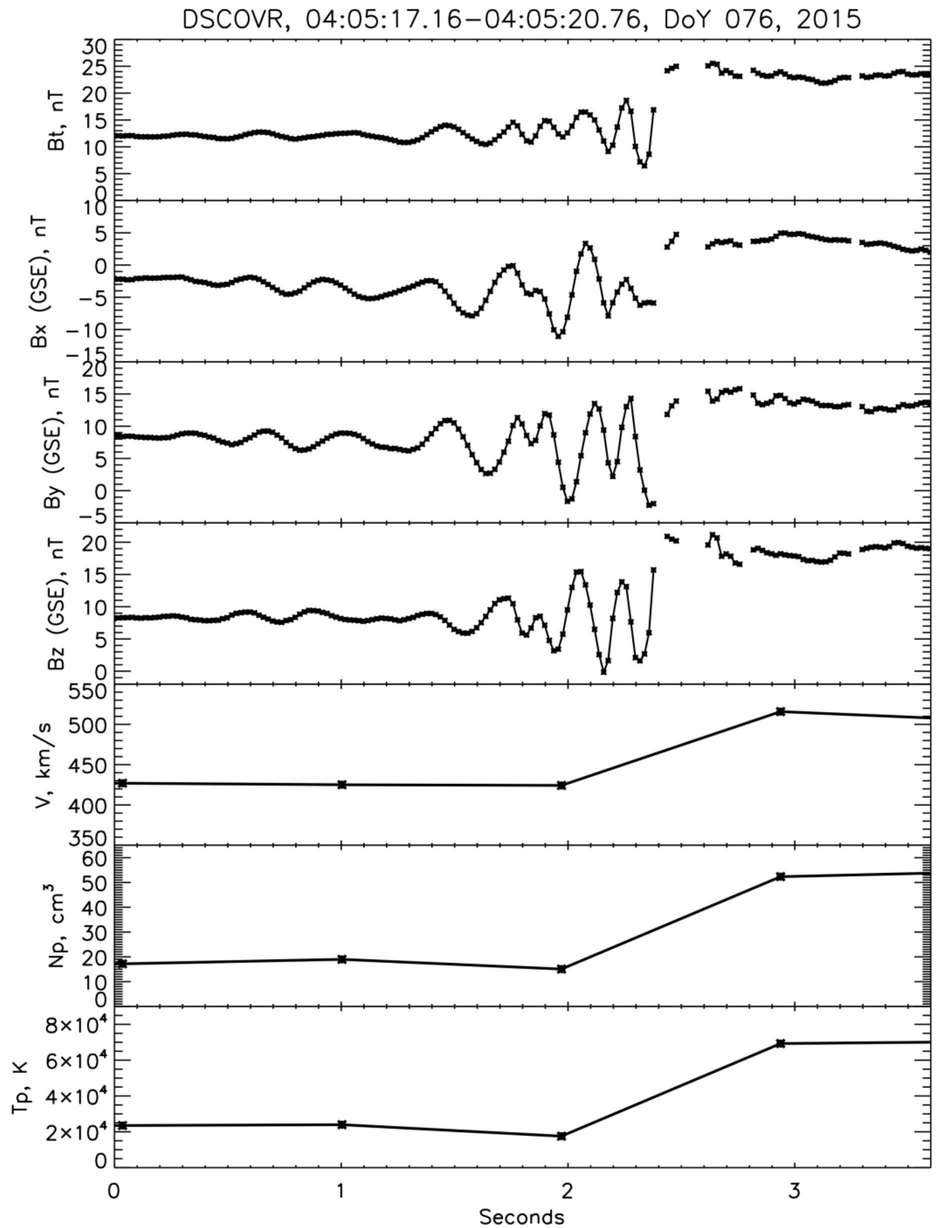


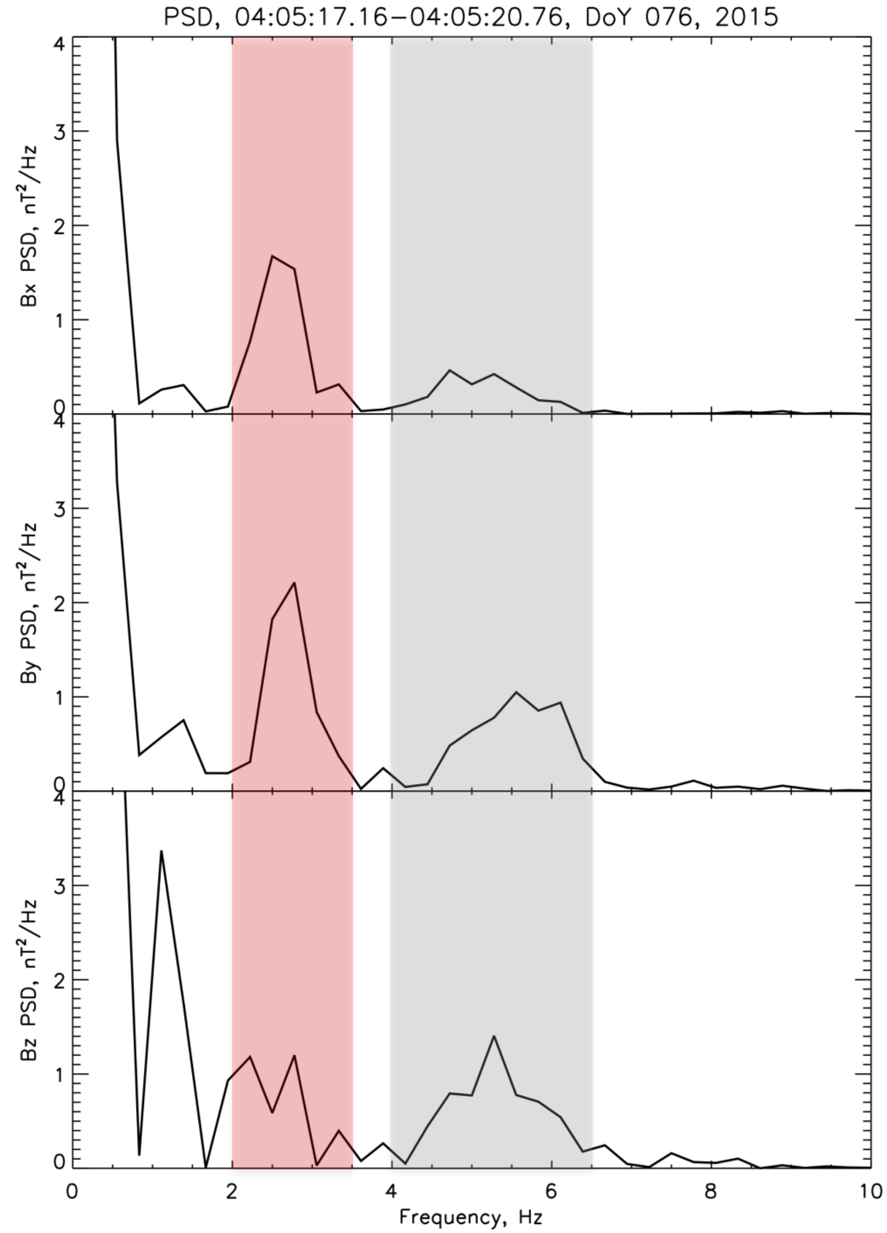
March 17, 2015 IP Shock

- A strong interplanetary shock was observed on March 17, 2015 at 04:05 UT.
- The shock was quasi-perpendicular (θ_{Bn} = 61 deg) and had a fast mode Mach number of M_f = 3.8.
- The shock appeared to have textbook jump characteristics.



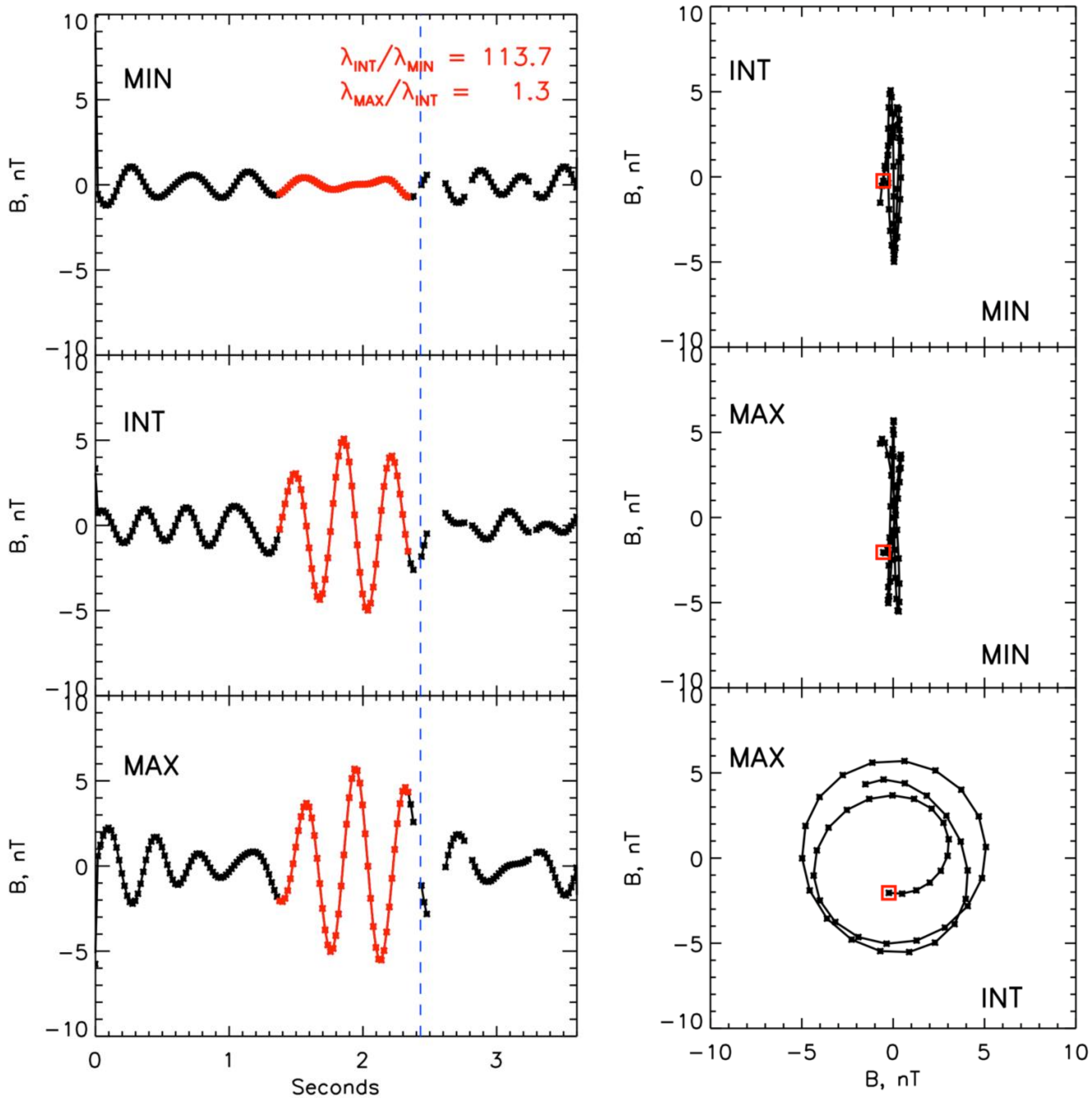
March 17, 2015 IP Shock





March 17, 2015 IP Shock

- 2.0 Hz < f < 3.5 Hz

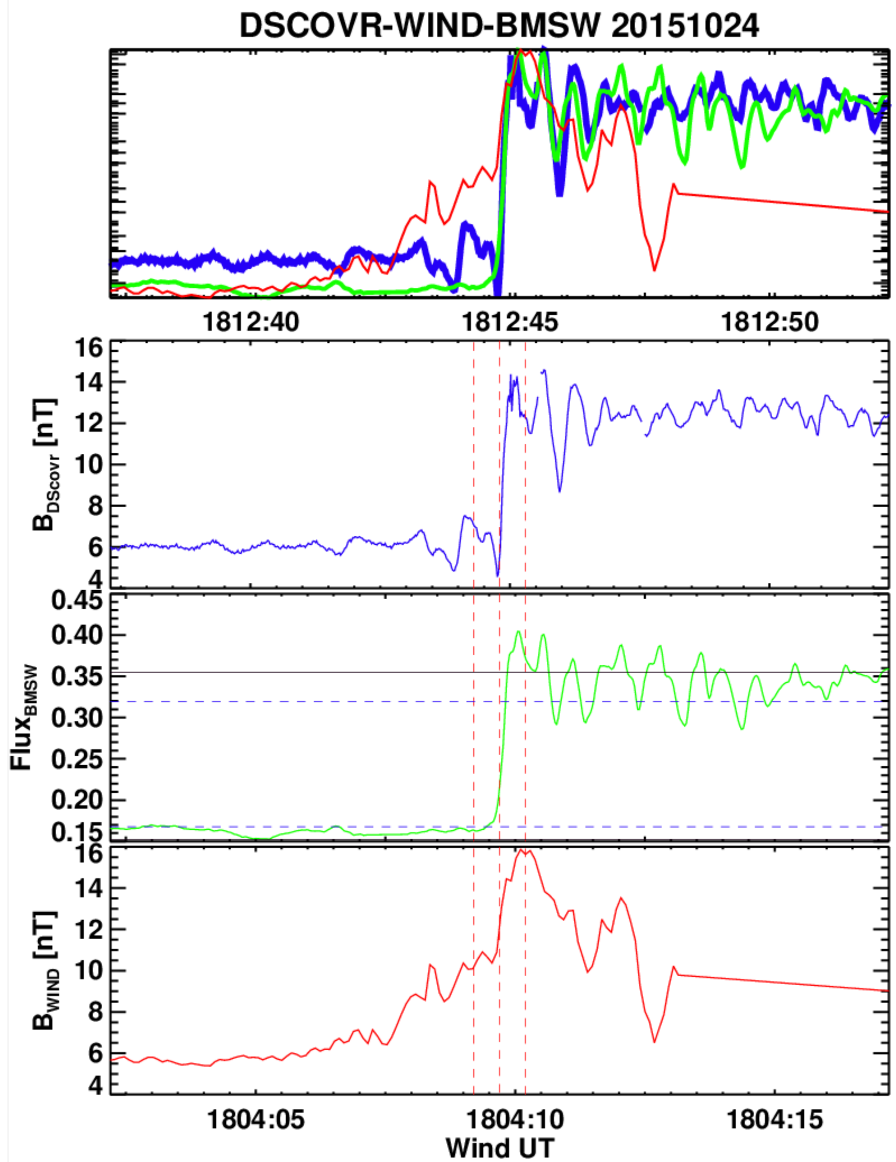


θ_{Bk} = 17 deg.

θ_{nk} = 39 deg.

DSCOVR Science: Plasma Waves

- The same interplanetary shock was observed by DSCOVR and by the Russian Spektr-R mission.
- The Czech BMSW instrument on Spektr-R provides 32 ms resolution solar wind flux measurements.
- DSCOVR provide 50 vectors/sec (20 ms) magnetic field data.
- Even though the spacecraft are separated by more than 100 Re, they observe the same frequency waves downstream of the shock.



Conclusions

- DSCOVR magnetometer data exceeds the Level 1 science requirements
- Unprecedented high-time resolution measurements already yielding new science results
  - Small spatial scale solar wind structures
  - Energy cascade and dissipation in the solar wind
  - Wave-particle interaction near interplanetary shocks
- Future DSCOVR studies will directly support Solar Probe Plus and Solar Orbiter inner heliospheric science objectives
- Once DSCOVR becomes NOAA's primary space weather monitor, continuous data will be available through NOAA's National Centers for Environmental Information (NCEI)